fallen in early morning, to the extent of 0.03 inch; at 8.43 rain again commenced to fall, becoming heavy about 9 a. m.; this lasted for ten minutes, and then subsided to a light fall, ending 10.20 a. m. The thermometer rose slowly from 65° at 8 a. m. to 67° at 9 a. m., but by 11.30 a. m. dropped to 49°. No thunder or lightning occurred either before, after, or during the prevalence of the tornado.

The topography of the country around the outskirts of Augusta is for the most part very hilly; the city is almost surrounded by a circle of elevations, from 200 to 300 feet in altitude; to the southward, however, the ground is comparatively low, flat and boggy, and it was from this opening that the storm entered the city. (See Chart No. VIII.)

No. 1 on the map was the first point struck by the tornado, although it was seen moving over a dense growth of pines situated about one-half of a mile back of the storm, or southwest of this place; the clouds appeared intensely black, but no funnel was then noticed. At No. 1 three large pines were uprooted, and all lay in a northeast direction; the distance between the outer and inner trees was 100 yards. The tornado then jumped over the pavilion, and continued in the air until No. 2 was reached; a partial descent was here made, resulting in twisting off one-half of a medium-sized pine; the broken portion was carried some 80 feet forward (or to the northeast). About 600 yards south-southeast of No. 2 a secondary or minor tornado tore away a tin roof on the south end of the glass works. From No. 2 another jump in the air occurred, descending on No. 3, a small frame house which was blown away, leaving nothing except the flooring upon which the two occupants of the house were standing, neither of whom were in the least injured; the débris of this house was also carried to the front and lodged against another small house 50 feet distant. It was here that several persons saw the funnel distinctly before it struck No. 3; they were standing east of the track about 300 yards away, and it appeared to them to have a shape like smoke coming from the stack of a locomotive engine, very black in front (northeast) and much brighter in the rear (southwest); they heard a subdued, roaring noise, and noticed the appendage twisting and writhing, but none could identify the direction in which the whirl rotated. The tornado bounded over the small house that No. 3 was lodged against, and came down into a small grove of pines, prostrating 3 of them which were lying in a northeast direction and twisting off 1 tree 15 feet from its roots, which latter lay pointing east; the space of ground occupied by these 4 trees, while standing, was not over 40 feet square. The tornado now continued its course to No. 5, which was a 2-room frame house on the west side of Twelfth street and crushed it to pieces; inside were 3 small children, and when the wreck was removed the children were found uninjured. Here the tornado again ascended, but descended on No. 6, a small frame dwelling standing on the southwest corner of Third avenue and Ninth street; this house was swung from its pillars, and the south end carried 5 feet toward the east; this shows beyond a doubt that the tornado was whirling from left to right, or in a direction contrary to the movement of the hands of a watch [see note]. After passing this point the tornado bounded up and next struck No. 7, also a small frame house, tearing off 12 feet of the chimney and scattered the fencing in the rear of the house; here the track of the storm was about 50 yards wide; it also wrecked a 2-room house in front of, and opposite to, No. 7, and then jumped across and demolished a kitchen standing 15 feet in rear of No. 8. Thus far along the route of the tornado the funnel was visible to many persons, but now the débris commenced flying fast and thick, covering the cloud to such an extent that nothing further could be seen of the funnel.

On Eighth street, west side (No. 9), between Gwinnett and Hopkins streets, the destruction was terrible; 8 small frame houses were literally torn to pieces and the fragments carried several hundred feet away but in the path of the storm. The track here was 50 yards wide; one house on the southwest corner of Eighth and Gwinnett escaped destruction, 4 houses on Eighth and Hall streets (No. 10), just opposite, and somewhat larger than those previously encountered, were terribly disfigured, 3 having the roofs carried away and the fourth almost razed to the ground; one of the roofs which was lifted into the air was carried forward so rapidly that when it struck Miller's Mill, having traveled at least 300 feet, it tore a large hole in the roof, but the storm itself had passed a little to the east of the mill building, tearing away some 200 feet of tin roofing on the adjoining buildings used for storing empty barrels, &c. Again making a long jump, No. 11 was reached; this structure is the roundhouse of the Central Railroad, and one-third of this was torn to pieces. Near this point another minor tornado developed, bursting out 140 feet of the east brick foundation of the Central Railroad machine shops (No. 12); this building is 50 feet wide and 160 feet long, and is located about 400 feet south of No. 11. The secondary storm continued in a north-northeast direction and tore away the tile roof of No. 13 (Perkins' old office), being the last seen of storm No. 3; it also was 50 yards wide. The main storm ascended after leaving No. 11, but came down and destroyed a small frame house (No. 14) on the south side of Fenwick street, between Fifth and Sixth streets, jumped back again into the air, and visited the front yard (No. 15) of Mrs. H. T. Russell on the south side of Walker street, between Fourth and Fifth streets. Here it rooted up and scattered about all the shrubbery in the yard and blew down on the sidewalk an immense water-oak tree, one of the oldest and probably as large as any tree in the city. It was 5 feet in diameter and fully 100 feet high; the fallen tree lay in a northeast direction. Again bounding up the storm crossed over and struck down a medium-sized tree standing on the west side of Fourth street, north of Walker street; this tree lay pointing toward the east. It is believed that at this point the tornado entirely disappeared.

[NOTE.—When any obstacle, house, or stone is pushed straight ahead by a uniform force, such as the pressure of a very uniform straight-lined gale, the movement of that obstacle is not necessarily in a straight line, but depends upon the shape of the obstacle and the resistance met with as it endeavors to move along the earth's surface. If, for instance, one end of the small frame building, No. 6, was more heavily loaded or more firmly fastened than the other end, or if some fastenings gave way last and after the other end had begun to move, then the final position of the building would make an angle with its original position; the building will have been twisted around, although the wind that struck it was blowing in a straight line; therefore, the conclusion as above drawn by Mr. Fisher seems open to revision.—C. A.]

NOTES BY THE EDITOR.

SENSIBLE TEMPERATURES.

As this term has been used by several persons with different significations it may be worth while to recall these and compare the definitions among themselves. In the Philosophical Transactions for 1826 of the Royal Society of London, Dr. W. Heberden advanced the idea that sensible cold depended on the rate at which the internal heat is carried off from the surface of the body. Assuming that the surface of a thermometer is analogous to that of the body he proposed to use its rate of cooling as an index to the sensible temperature. He, therefore, warmed a thermometer to about 120° F., and allowed it to cool in the wind; the time required for it to cool from 100° down to 80°, or the amount by which it cooled in ten seconds, constituted, according to him, a measure of the sensible cold. [The rate of fall of the column of mercury depends largely on the internal resistance of the capillary tube, and the method is therefore not a correct measure of the cooling of the surface of the bulb.]

About 1871, Mr. J. W. Osborne, of Washington, proposed to use the cooling surface of a paper cylinder that was filled with water; the mass of water was about 4 pounds in weight, and as it was kept well stirred the temperature could be accurately given by means of a thermometer. The ratio of the mass to the cooling surface was about the same as that in the human body. He proposed to determine the time required for this mass of water to fall 1° in temperature after it had been warmed to a little above blood heat. In order to distinguish between the influence of atmospheric temperature and vapor he made similar observations with a cylinder of water whose surface was always kept dry. As the results of his experiments he found that the sensible temperature affecting human beings is very different from that given by the ordinary thermometer; that the fluctuations in it are far greater than most persons have any idea of; that there are sudden oscillations quite as important as the great changes from day to day; that the wind is often more important than the temperature; and that it causes the instantaneous oscillations. The rate at which the cylinder of water loses its temperature is proportional to the rate at which the human body must supply heat in order to maintain its own constant temperature, and this rate is the basis of our conception of sensible temperature. By securing the cooperation of a large number of observers Mr. Osborne sought to also establish a scale of subjective temperature for comparison with the sensible temperatures given by the apparatus just described, and found a general parallelism in the results.

In a paper read before the American Climatological Association, June 1, 1894, Prof. M. W. Harrington proposed that the temperature of the wet bulb should be used as a measure of the sensible temperatures, while the depression of the wet bulb below the dry bulb indicates the dryness and the cooling influence of the wind and the consequent evaporation from the skin.

We see here the successive steps of progress by which we have passed from the neglect of moisture to its full consideration.

OBSERVATIONS AT HONOLULU, HAWAIIAN ISLANDS.

Meteorological observations at Honolulu, Republic of Hawaii, by Curtis J. Lyons, Meteorologist to the Government Survey.

Pressure is corrected for temperature and reduced to sea level, but the gravity correction, —0.06, is still to be applied.

The absolute humidity is expressed in grains of water, per cubic foot, and is the average of four observations daily.

The average direction and force of the wind and the average cloudiness for the whole day are given unless they have varied more than usual, in which case the extremes are given. The scale of wind force is 0 to 10.

The rainfall for twenty-four hours is given as measured at 6 a. m. on the respective dates.

March, 1895.	Pressure at sea level.			Temperature.					Humidity.			Wind.		Cloudiness.	Rain measured at 6 a. m.
	9 a. m.	3 p. m.	9 p. m.	6 a. m.	2 p. m.	9 p. m.	Maximum.	Minimum.	Relative. 9 a. m.	Relative. 9 p. m.	Absolute.	Direction.	Force.		
	Ins.	Ins.	Ins.	°	°	°	°	°	%	%					Ins.
1..	30.22	30.15	30.22	68	74	69	74	65	60	57	4.9	nne.	4	4	.00
2..	30.20	30.14	30.17	67	73	67	75	67	53	67	4.8	nne.	5-3	1-4	.00
3..	29.20	30.12	30.18	64	74	69	75	62	52	57	4.6	ene.	3	3-8	:00
4..	30.18	30.07	30.15	66	73	66	75	60	56	66	4.8	ne.	4	7-2	.00
5..	30.11	30.02	30.10	63	74	67	77	61	59	68	4.9	e-se.	3	4	.00
6..	30.06	29.97	30.04	65	75	70	76	61	68	76	5.6	sw.	1	9	.00
7..	30.06	29.96	30.08	70	76	69	78	68	77	81	6.3	sw.	2	8-3	.00
8..	30.05	29.97	30.05	68	77	72	79	63	74	77	6.3	sw.	3	5	T.
9..	30.08	29.99	30.05	70	78	72	80	67	77	85	7.2	sw.	4	7	.00
10..	30.10	30.03	30.11	68	75	66	77	67	57	72	5.5	ne.	5-2	1	.09
11..	30.16	30.09	30.16	64	75	70	77	62	52	68	4.9	ene.	5-2	8	.00
12..	30.20	30.08	30.16	69	74	70	75	68	54	67	5.2	nne.	6	3	.00
13..	30.18	30.10	30.16	66	75	69	75	66	55	53	4.5	nne.	5	4	.00
14..	30.17	30.11	30.20	69	72	69	73	66	63	70	5.0	nne.	6	6	.00
15..	30.16	30.10	30.17	68	72	70	74	77	65	65	5.3	ne.	6	5	.10
16..	30.19	30.11	30.17	66	70	69	74	65	76	70	5.5	nne.	6	8	.62
17..	30.15	30.09	30.15	68	72	70	75	67	62	64	4.9	ne.	5	4	.40
18..	30.14	30.08	30.20	69	74	70	75	68	63	67	5.4	ene.	6	3-7	.05
19..	30.24	30.16	30.23	69	74	70	76	69	60	64	5.2	ene.	5	4	.01
20..	30.23	30.15	30.23	69	74	70	75	69	71	65	5.3	nne.	5	4	.00
21..	30.23	30.13	30.18	70	73	70	76	69	57	58	4.9	ene.	5	4	.01
22..	30.18	30.09	30.15	68	76	71	77	67	56	64	5.1	ne.	4	4	.00
23..	30.13	30.05	30.13	69	76	70	77	68	57	64	5.2	ne.	4	4	.00
24..	30.16	30.04	30.14	69	72	70	77	68	60	68	5.5	nne.	4	2-4	.02
25..	30.15	30.08	30.15	64	70	64	71	68	63	70	4.4	nne.	7	4	.01
26..	30.19	30.10	30.17	63	70	66	70	60	63	68	4.6	nne.	5	7	.04
27..	30.19	30.09	30.17	65	70	67	73	60	63	71	5.0	ne.	4	4	.18
28..	30.16	30.08	30.13	64	74	69	75	63	75	68	5.5	ne.	5	7	.20
29..	30.16	30.08	30.14	64	75	70	76	63	69	68	5.9	nne.	1-4	5	.25
30..	30.14	30.08	30.16	67	75	70	77	66	68	68	5.4	nne.	4	5	.05
31..	39.15	30.07	30.16	68	75	72	77	67	61	64	5.4	ne.	4	5	.01
	30.159	30.077	30.148	66.8	73.8	69.1	75.5	65.2	62.7	67.5	5.2	....	......	......	2.04

Mean temperature: 6 + 2 + 9 + 3 is 69.9; the normal is 70.9; extreme temperatures, 80° and 60°.

An unusual proportion of northerly winds.

Disturbance periods occurred on the 15th and 26th.

The average absolute humidity is 5.25, the driest atmosphere on record during a period of four and one-half years.

AMERICAN ASSOCIATION OF STATE WEATHER SERVICES.

In a circular letter of July 12, Maj. H. H. C. Dunwoody, president of the association, announces—

The fourth annual convention of the American Association of State Weather Services will be held at Indianapolis, Ind., Wednesday and Thursday, October 16, 17, 1895. It was the intention to have the meeting of the Association held in Springfield, Mass., in conjunction, as in former years, with the American Association for the Advancement of Science, but, in view of the fact that three of the four previous State Weather Service conventions have been held in eastern cities, it is considered but fair to the directors of the services in the central and western portions of the country that a place of meeting for this year's convention be selected that could be more conveniently and economically reached.

* * * * * * *

The Chief of the Bureau is anxious that the forthcoming meeting shall be a successful one, and authorizes me to say that, as the object of these conventions is to increase the usefulness of the Bureau, permission to attend the convention will be granted all Weather Bureau officials on State Weather Service work, the necessary absence not to be charged against annual leave.

* * * * * * *

Papers upon topics of interest to State Weather Services are solicited, and if authors of such articles as may be prepared find it impracticable to attend the convention, they are requested to forward to the secretary any paper that may be prepared.

THE WARM WAVE OF MARCH 27–29.

As the area of low pressure No. XVIII moved from the coast of Washington on the 26th into Assinniboia on the 28th and Missouri on the 31st, it was accompanied by southerly winds and high temperatures that are rare at this season of the year. The maximum temperatures for the month were the highest on record, as follows: On the 27th, Port Angeles, 59°; Havre, 72°; Miles City, 77° (on this date the highest temperatures of the current March occurred throughout the northern and eastern portions of the Rocky Mountain plateau). On the 28th, Pierre, 84°; Concordia, 93°; Topeka, 91°; Dodge City, 93°; Wichita, 91°; Kansas City, 88°; Springfield, Mo., 86°; Memphis, 87°. On the 29th, Omaha, 85°; Des Moines, 88°; Dubuque, 86°; Davenport, 82°; Keokuk, 84°; St. Louis, 85°; Springfield, Ill., 84°; Chicago, 80°; Indianapolis, 82°; Cairo, 84°; Louisville, 86°; Lexington, 83°; Cincinnati, 84°; Columbus, Ohio, 79°; Nashville, 85°; Chattanooga, 85°; Knoxville, 83°; Montgomery, 86°; Atlanta, 83°. On the 30th the maximum temperatures of the month, averaging 84° and 85°, were experienced in the interior of the south Atlantic States, but these were not the highest on record for that region.

In general, it will be noticed that there was a steady, progressive, southeastward movement of an area of high temperature from British Columbia to the Atlantic coast, and that the temperatures were on the average much higher (90° to 93°) in Kansas on the 28th than in any other region on that day or on the other days. The average of the maximum temperatures on successive days was about as follows: On the 27th, from eastern Montana to eastern Colorado, 75°; on the 28th, from South Dakota (84°) to northern Texas (85°), the maximum, in Kansas, 92°; on the 29th, from Iowa to Georgia and Ohio, 85°; on the 30th, in the south Atlantic States, 84°. This general diminution of maximum temperatures as we go southeastward from day to day is also noticeable in the individual maxima of each day, thus, on the 28th, the maxima in Kansas were 4° or 5° higher than those in Missouri, and on the 29th the maxima in Iowa were higher than those in Tennessee, Kentucky, and Ohio. If the air had been nearly calm one might attribute this distribution of maxima to insolation and cloudiness, but inasmuch as high southerly winds prevailed wherever a maximum temperature was recorded it is necessary to consider the effect of the movement of the air. Strong horizontal winds rarely exist without causing ascending and descending currents of equal importance. The ascending currents carry the warm, moist, surface air upward to cool and form clouds and rain. If, after rain has fallen from these currents and while the latent heat of the condensed moisture remains in the air, the latter is again quickly brought down to the ground, it will be warmer than before it ascended. But this process is not the one that went on during the 28th to form the hot winds in Kansas, nor did it form the hot winds of the 29th in Iowa, Illinois, and the Ohio Valley, for on those days no rain fell in those or any neighboring regions. The daily map shows that on the 28th, while the temperature was rising and the pressure falling in Kansas, with high southerly winds, pressure was falling, but temperature also falling, with the advent of cool northwest winds, in central Wyoming, Colorado, and New Mexico. Within this region the stations that represent the beginning of the eastern slope—such as Lander, Cheyenne, Denver, Pueblo, and

Santa Fe—show that on the 28th, a. m., at an average height of 5,700 feet, the average temperature was 50.8°; later in the day, for these stations, the average of the maxima was 67.6°, and the average for 8 p. m. was 60.8°. At an average distance of 300 miles eastward of this ridge, and especially in Kansas, the averages for Dodge City, North Platte, Amarillo, Concordia, Wichita, and Kansas City show that for an average elevation of 2,132 feet the average temperature on the 28th, a. m., was 52.3°; later in the day the average of maxima was 88.2°, and for 8 p. m. 77.7°.

The mechanical process by which the high temperatures of the 28th, in Kansas, were brought about was evidently as follows: An area of low pressure extended from Alberta southeast toward Nebraska; air was flowing toward this both from a high pressure in the region of the Upper Lakes and Hudson Bay and from a slightly higher pressure over the Rocky Mountain plateau; brisk and high westerly winds prevailed over the plateau region from British Columbia to Mexico during the 28th, evidently fed from a region of still higher pressure off the Pacific coast; the air over the plateau was pushed eastward by its own elastic expansion toward a region of low pressure, and, therefore, so long as it did not descend to any extent, was cooled by this expansion; hence, both pressure and temperature fell over the plateau region in addition to the fall due to the advent of any still cooler air. But when these westerly winds began, on the morning of the 28th, to descend the slope into Kansas and Nebraska, they were at once warmed up by compression more than they were cooled by the expansion into the area of low pressure. This warming being added to the regular diurnal insolation and to the general effect of transfer from north to south raised the maxima of the 28th in Kansas and Missouri up to their abnormal values.

On the 29th a precisely similar process went on, except only that the descending currents were now farther east, namely, Illinois and the Ohio Valley, and having already been cooled down by radiation the general temperature effect was less intense but still decidedly marked.

By taking the difference between the averages above given for the 28th it will be seen that for a descent of 3,538 feet along the eastern slope of the plateau there was an increase of temperature of 1.5° at 8 a. m. and 16.9° at 8 p. m., but 20.8° at the time of diurnal maximum. This latter figure corresponds to a rate of increase of 1° for 170 feet descent.

METEOROLOGICAL TABLES.

[*Prepared by the Division of Records and Meteorological Data.*]

Table I gives, for about 130 Weather Bureau stations making two observations daily and for about 20 others making only the 8 p. m. observation, the data ordinarily needed for climatological studies, viz, the monthly mean pressure, the monthly means and extremes of temperature, the average conditions as to moisture, cloudiness, movement of the wind, and the departures from normals in the case of pressure, temperature, and precipitation.

Table II gives, for about 2,400 stations occupied by voluntary observers, the extreme maximum and minimum temperatures, the mean temperature deduced from the average of all the daily maxima and minima, or other readings, as indicated by the numeral following the name of the station; the total monthly precipitation, and the total depth in inches of any snow that may have fallen. When the spaces in the snow column are left blank it indicates that no snow has fallen, but when it is possible that there may have been snow of which no record has been made, that fact is indicated by leaders, thus (. . . .).

Table III gives, for about 30 Canadian stations, the mean pressure, mean temperature, total precipitation, prevailing wind, and the respective departures from normal values. Reports from Newfoundland and Bermuda are included in this table for convenience of tabulation.

Table IV gives, for 82 stations, the mean hourly temperatures deduced from thermographs of the well-known pattern manufactured by Richard Bros., Paris, described and figured in the Report of the Chief of the Weather Bureau, 1891–'92, p. 29.

Table V gives, for 67 stations, the mean hourly pressures as automatically registered by barographs of the pattern manufactured by Richard Bros., Paris, except for Washington, D. C., where Foreman's barograph is in use. Both instruments are described in the Report of the Chief of the Weather Bureau, 1891–'92, pp. 26 and 30.

Table VI gives, for 136 stations, the arithmetical means of the hourly movements of the wind ending with the respective hours, as registered automatically by the Robinson anemometer, in conjunction with an electrical recording mechanism, described and illustrated in the Report of the Chief of the Weather Bureau, 1891–'92, p. 19.

Table VII gives the danger points, the highest, lowest, and mean stages of water in the rivers at cities and towns on the principal rivers; also the distance of the station from the river mouth along the river channel.

Table VIII gives the maximum, minimum, and mean readings of the wet-bulb thermometer for 135 stations, as determined by observations of the whirled psychrometer at 8 a. m. and 8 p. m., daily.

The difference between mean local time and seventy-fifth meridian time is also given in the table.

Table IX gives, for 133 stations, or all that make observations at 8 a. m. and 8 p. m., the four component directions and the resultant directions based on these two observations only and without considering the velocity of the wind. The total movement for the whole month, as read from the dial of the Robinson anemometer, is given for each station in Table I. By adding the four components for the stations comprised in any geographical division one may obtain the average resultant direction for that division.

Table X gives the total number of stations in each State from which meteorological reports of any kind have been received, and the number of such stations reporting thunderstorms (T) and auroras (A) on each day of the current month.

Table XI gives, for 42 stations, the percentages of hourly sunshine as derived from the automatic records made by two essentially different types of instruments, designated, respectively, the thermometric recorder and the photographic recorder. The kind of instrument used at each station is indicated in the table by the letter T or P in the column following the name of the station.

Table XII gives the records of hourly precipitation as reported by stations equipped with automatic gauges, of which 37 are known as float gauges and 7 as weighing rain and snow gauges.

Table XIII gives the record of excessive precipitation at all stations from which reports are received.

Table XIV gives a record of the heaviest rainfalls for periods of five and ten minutes and one hour, as reported by regular stations of the Weather Bureau furnished with self-registering rain gauges.

Additional information concerning the tables will be found in the January, 1895, REVIEW.